

CALiPER

Snapshot Downlights

Downlights are a staple of residential, hospitality, and commercial lighting, usually providing ambient illumination but sometimes focal lighting. Originally, downlights featured directional incandescent/halogen lamps—although in some cases omnidirectional lamps were installed, with substantial reductions in efficiency. Later, compact fluorescent (CFL) downlights became a dominant part of the market, offering higher efficacy and longer lifetimes. However, CFL-based downlights often had low luminaire efficiency due to the omnidirectional lamp emissions, as well as some lighting quality issues.

Because of the relatively low efficiency of incumbent technologies, downlighting was among the earliest lighting applications where LED offered competitive performance. At their peak in 2011, downlights made up approximately 25% of the luminaires in the LED Lighting Facts database. While the number of listed downlights has continued to increase, reaching almost 3,000 today, they now represent only about 10% of the listed luminaires. This decline is not due to poor performance, however. It is more likely due to the increasing feasibility of LEDs in other categories. In fact, the directional output of LEDs remains well-suited for the downlight form factor, allowing for higher efficacy and better lighting quality compared to CFLs. Now, however, the superiority of LED downlights over competing products may be limiting further performance gains, as the industry focuses on other issues, such as cost.

While the 6-inch aperture “recessed can” is the predominant type, the downlight category on LED Lighting Facts includes a wide variety of products. This includes products with either round or rectangular apertures ranging from approximately 2-inches to 12-inches in width. It also includes standard integrated-LED downlights, as well as retrofit kits that are intended for insertion into an existing housing. With output ranging from a few hundred to more than 10,000 lumens, it’s clear that the products in the downlight category are intended for a variety of applications.



March 10, 2016

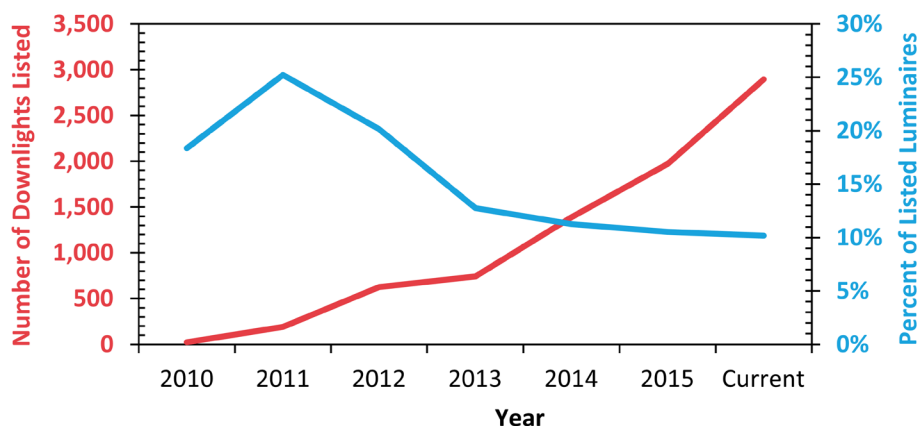
2,355 Partners

39,117 Total Active Products

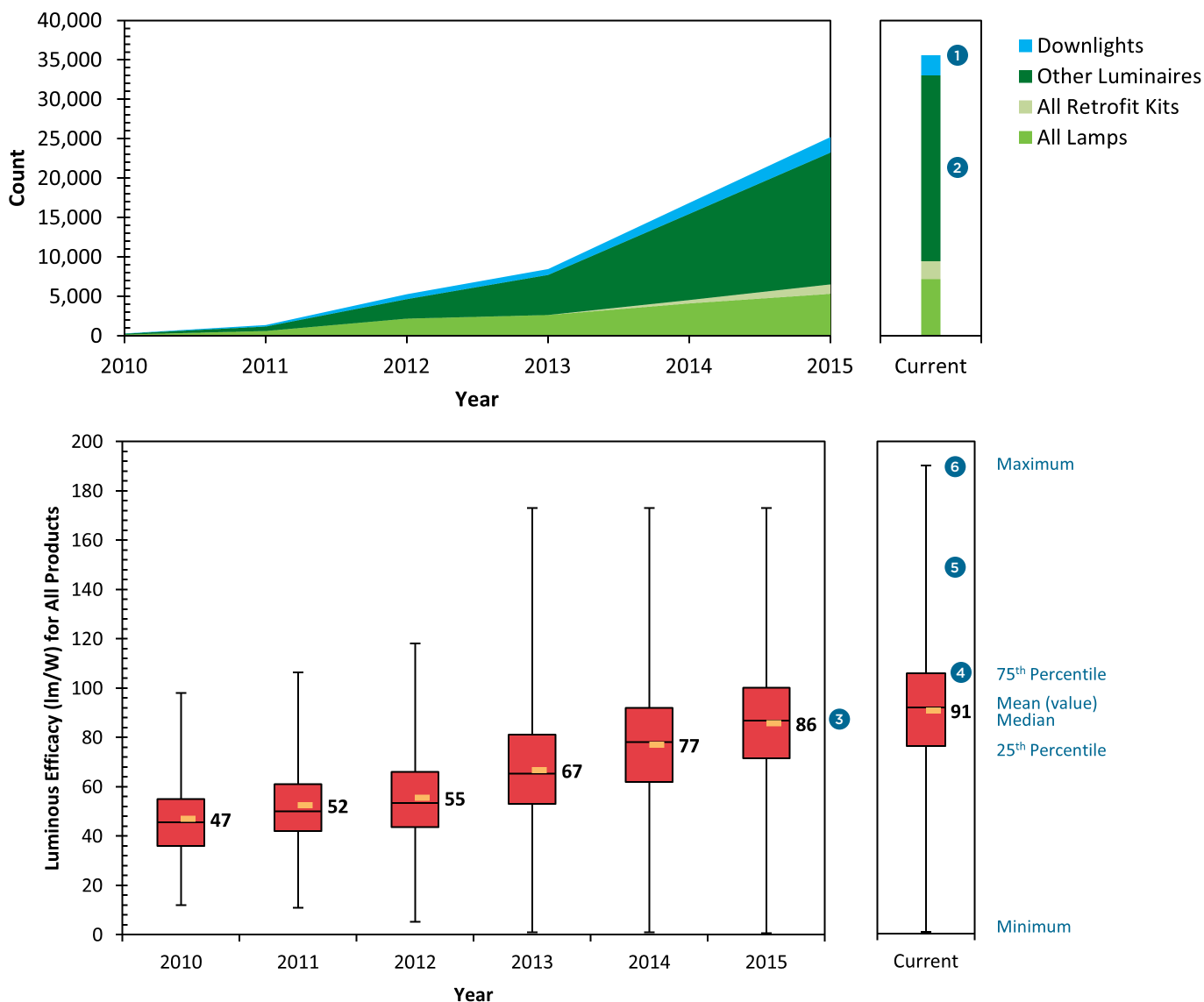
Report Highlights

- Across all products, efficacy gains continue to track at approximately 10 lm/W per year. The growth rate is slowing for luminaires, but increasing for lamps.
- The efficacy of LED downlights is lower than most of the LED luminaire types, although it is higher than for downlights using conventional light sources. The mean efficacy has increased by just eight lumens per watt over the past 20 months.
- Most of the listed LED downlights fall into traditional lumen output ranges for residential and commercial applications. A wide variety of performance is available.
- In contrast with other LED luminaires, the mean input power has dropped for LED downlights over the past five years, and the mean output has only increased slightly.
- LED downlights tend to offer higher color fidelity (CRI) than other LED product types, with 38% offering a CRI greater than 90.

AT A GLANCE DOWNLIGHTS LISTED BY LED LIGHTING FACTS



All Products Listings & Efficacy Over Time



1 The growth of the LED Lighting Facts database continues to accelerate. As of July 1, 2015, there were more than 25,000 listed products. More than 13,000 products were added in the subsequent eight months.

2 The rate of increase in the number of luminaires listed has outpaced lamps and retrofit kits. Luminaires now make up approximately 79% of the LED Lighting Facts database.

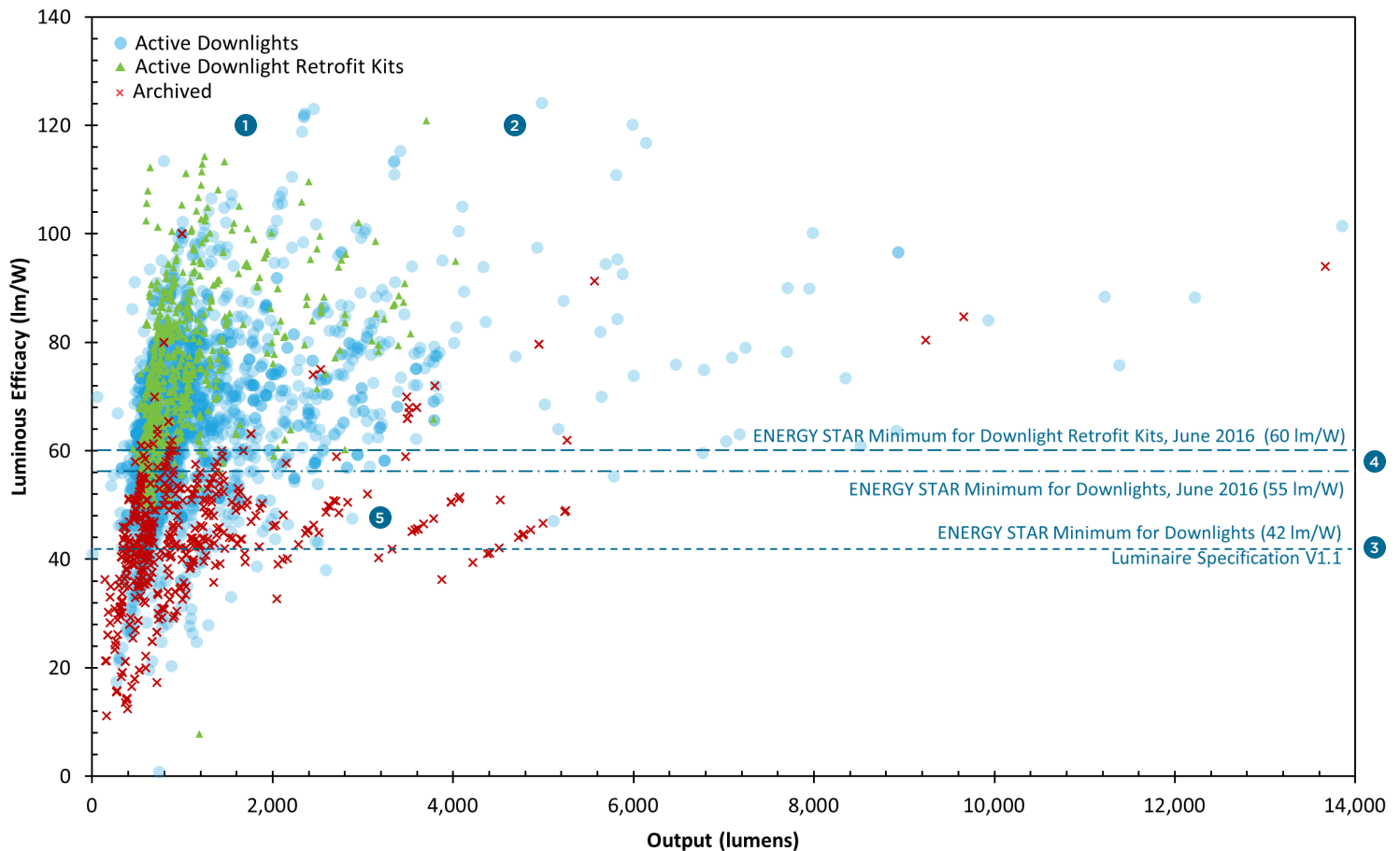
3 The mean efficacy for all listed products continues to grow at a steady rate of approximately 10 lm/W per year. The range for the middle 50% of products is increasing at a similar rate.

4 Although it is not shown in this chart, the mean efficacy for products listed after July 1, 2015, was 99 lm/W. This value is higher than the current mean listed, because the current mean includes all products still listed, some of which were first added in 2009.

5 Nearly 70 currently listed products exceed 150 lm/W. These products include industrial fixtures, troffers, linear fixtures, roadway fixtures, and linear lamps. They come from a number of manufacturers, and almost all have a CRI greater than 80 and vary between 3000 K and 5000 K.

6 The most efficacious product currently listed by LED Lighting Facts (190 lm/W) is a T8 lamp. The most efficacious downlight is 124 lm/W.

Downlights Efficacy & Output



1 Nearly 1,700 of the 2,879 currently listed downlights (59%) emit between 500 and 1,000 lumens, which is most typical of a residential or hospitality application. About 33% of the currently listed products emit between 1,000 and 2,500 lumens, which is more typical of a commercial application.

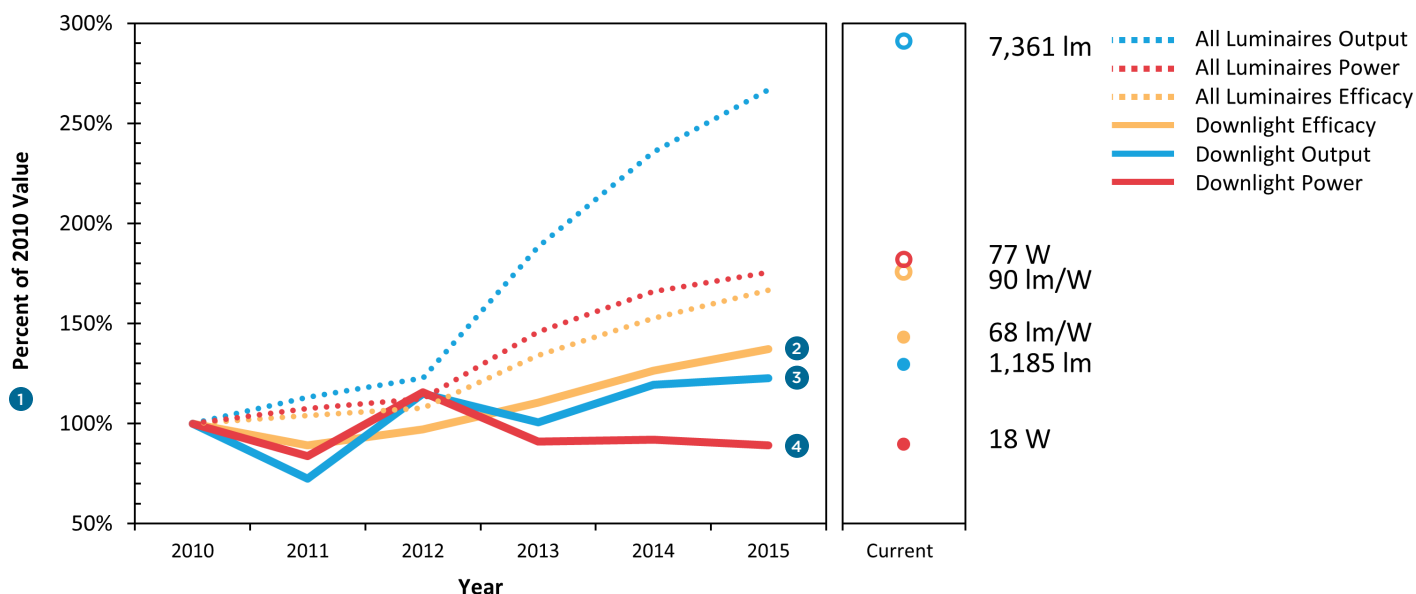
2 Four dozen downlights currently listed by LED Lighting Facts emit more than 4,000 lumens. While still a relatively small number, it is substantially more than was available in April 2014, according to the last CALiPER Snapshot Report that included downlights.

3 The minimum efficacy requirement for ENERGY STAR qualification of downlights is currently 42 lm/W. A vast majority of currently listed products (97%) meet that threshold.

4 Beginning in June 2016, the ENERGY STAR minimum efficacy requirements will increase to 55 lm/W for downlights and 60 lm/W for downlight retrofit kits. About 80% of currently listed downlights and 88% of downlight retrofit kits meet the new thresholds.

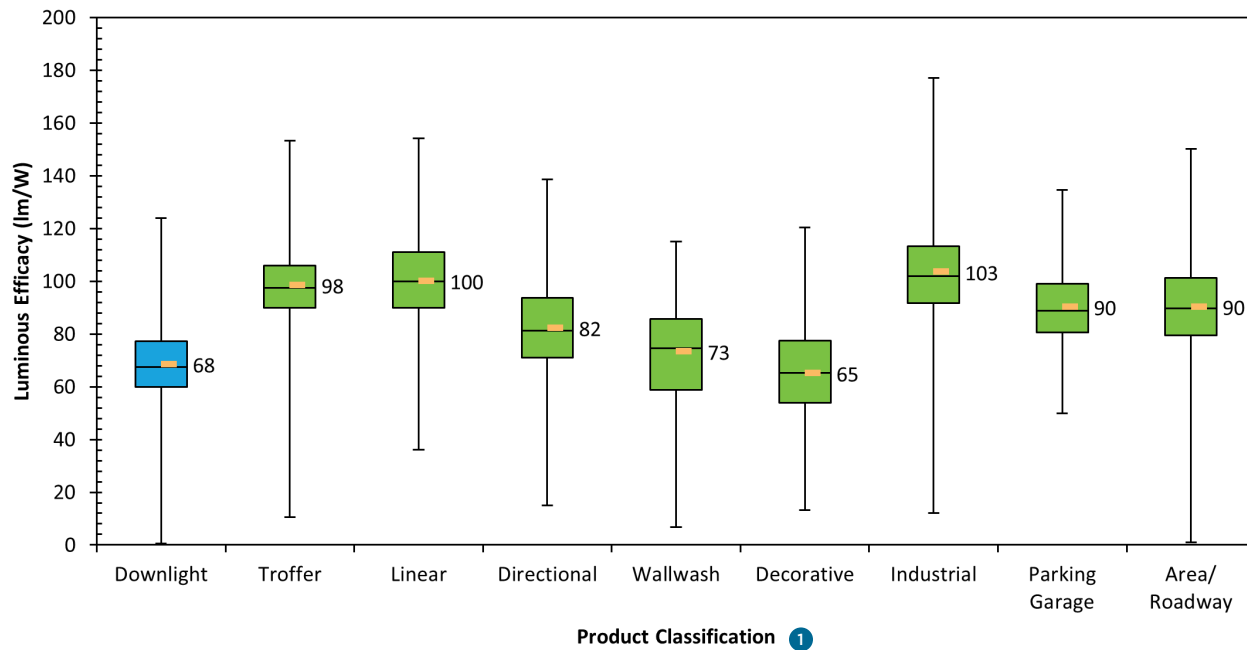
5 A vast majority of the archived downlight products fall below 60 lm/W, which generally indicates that the lowest-performance products are the ones being discontinued.

Downlights Average Efficacy, Output, & Power Trends



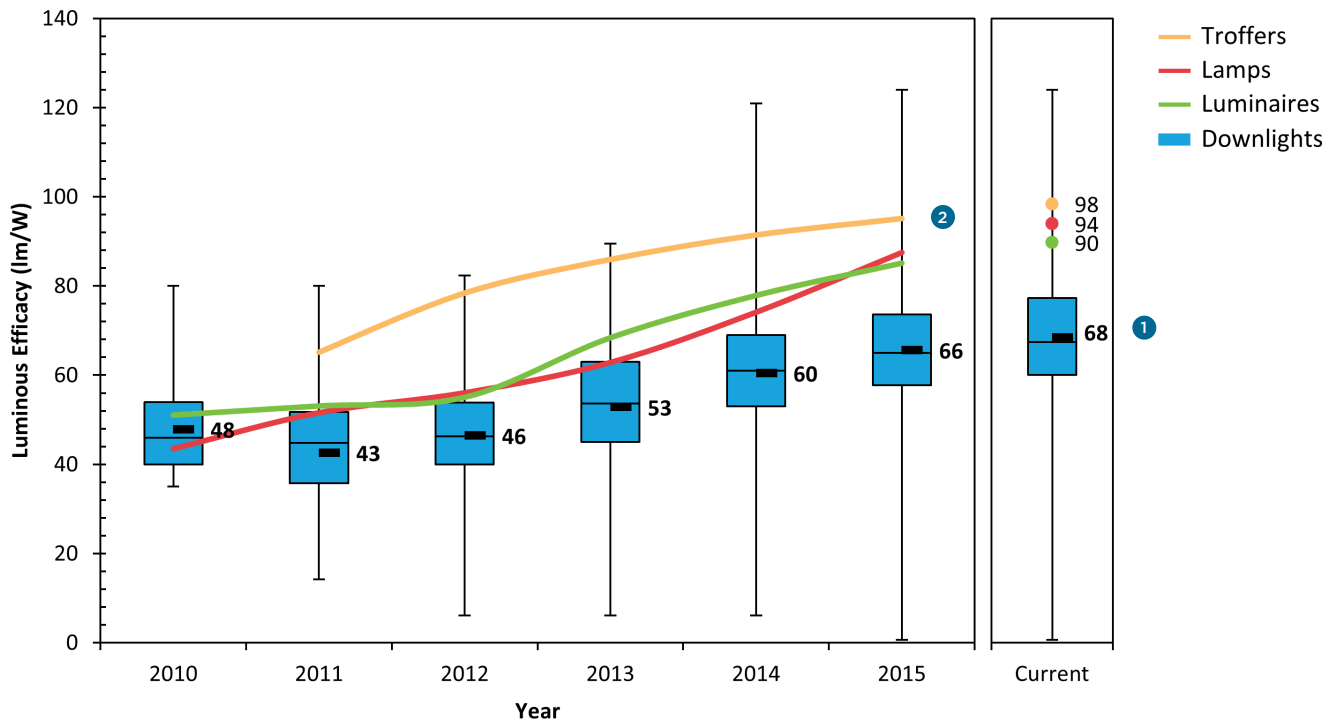
- For this chart showing average performance, all values have been normalized to the 2010 data point. At that point, the efficacy for downlights was 48 lm/W and the efficacy for all listed luminaires was 51 lm/W. The downlights emitted substantially less light (915 lumens versus 2,528 lumens) and correspondingly drew less power.
- The increase in efficacy for luminaires as a whole (76%) has outpaced the increase in efficacy for downlights (43%). This can possibly be traced to the growth of luminaire categories, such as troffers, that often have less optical control than downlights (which usually results in higher efficacy), among other physical differences.
- The mean lumen output for all luminaires has increased substantially since 2010, whereas the mean lumen output for downlights has increased less than 30%. This is principally because the output range for many downlight applications is lower (less than 2,000 lumens) than for other form factors. In other words, in 2010 LED downlights provided sufficient lumen output, whereas other form factors still needed development.
- Commensurate with the changes in output and efficacy, the average power draw for LED downlights has actually decreased over the past five years, whereas the average power draw for other luminaire types has substantially increased.

Downlights Current Efficacy Versus Other Luminaire Types



- ① The mean efficacy for LED downlights currently listed by LED Lighting Facts is lower than the mean efficacies of the listed products in all other major luminaire categories except decorative fixtures. There are a number of possible contributing factors. First, the product categories where the incumbent technology (e.g., linear fluorescent, high-intensity discharge) is more efficacious all have LED products that are more efficacious; this includes troffer, linear, industrial, parking garage, and area/roadway fixtures. The requirements for optical control and other differences in form factor likely also contribute to the differences, as do qualification thresholds for energy efficiency programs and lighting quality needs.

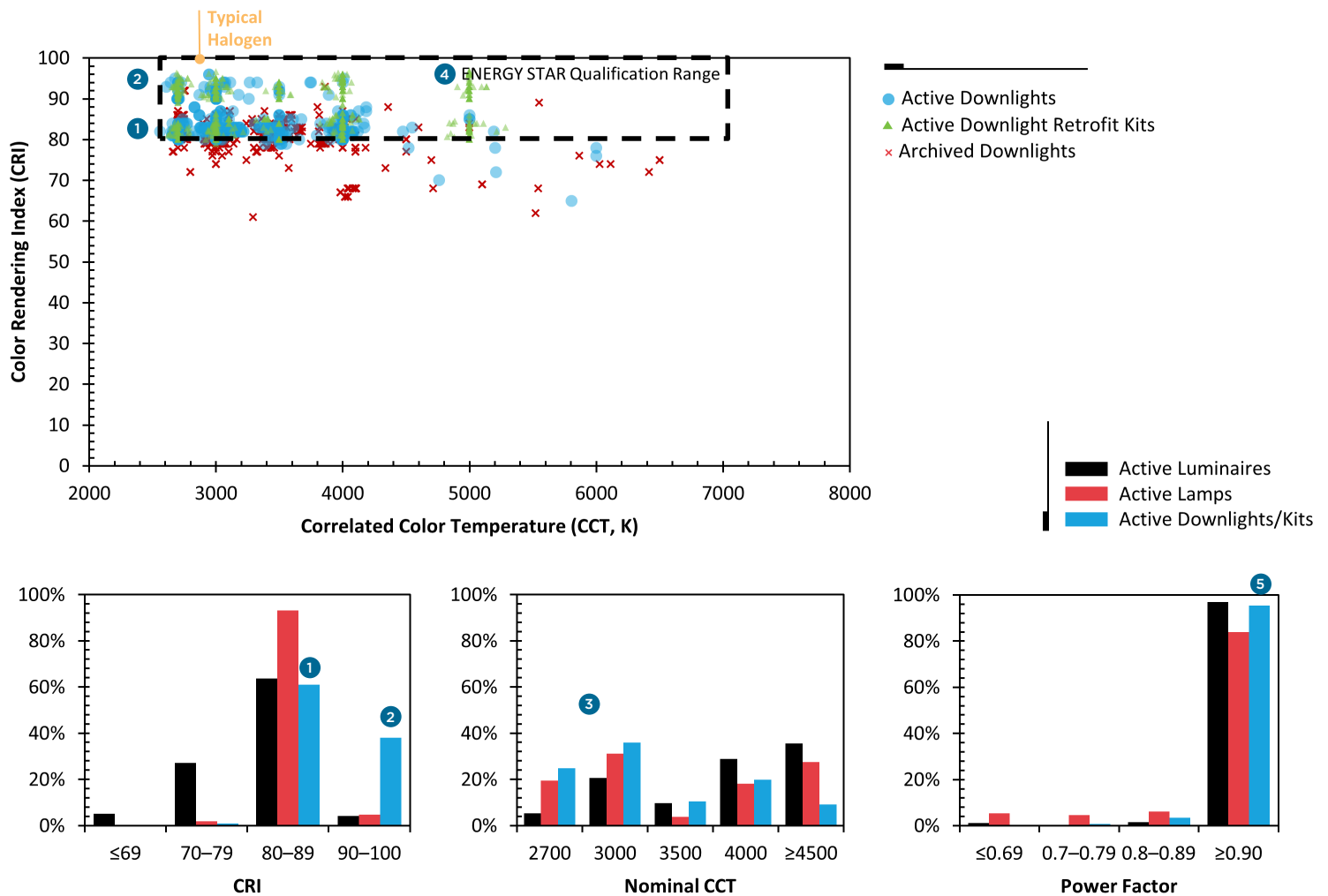
Downlights Efficacy Trends Versus Other Product Types



① The mean efficacy for LED downlights has increased somewhat over the past five years, following an initial dip in 2011, which may have been due to sample size. Unlike some other categories, the mean efficacy for downlights has changed little over the past eight months.

② There is a notable contrast in the rates of change for lamp efficacy and luminaire efficacy (and for the specific subtypes shown: downlights and troffers). While the efficacy of lamps is increasing at an increasing rate, the efficacy of luminaires is increasing at a decreasing rate. The exact cause and meaning of this discrepancy are unclear at this time, but are worth monitoring.

Downlights Color Quality & Power Quality



1 A majority (61%) of downlights (including downlight retrofit kits) listed by LED Lighting Facts have a CRI in the 80s, with most between 80 and 85.

2 The downlight category features a greater percentage of products with a CRI in the 90s (38%) than any other product category in the LED Lighting Facts database. This is likely because many of the products are intended for residential and hospitality applications.

3 A majority of the listed downlights have a nominal CCT of either 2700 K or 3000 K, with slightly more at 3000 K. These CCTs are the closest to that of halogen lamps, which are often around 2800 K to 3000 K. Still, there are a substantial number of downlights at all nominal CCTs, reflecting the diversity of existing downlights.

4 ENERGY STAR requires lamps to have a CRI of at least 80 and a nominal CCT between 2700 K and 6500 K. More than 99% of the currently listed downlight products meet both criteria.

5 A vast majority (95%) of downlights that are currently listed by LED Lighting Facts (and that report this optional metric) have a power factor of 0.90 or greater.

Discussion **How do LED Downlights stack up?**

In the past two years, LED technology has progressed rapidly, which is reflected in the data available through LED Lighting Facts. The number of available products is increasing, along with the average efficacy and output performance. Today, based on photometric performance alone, there appears to be a downlight to fulfill just about every need. It's reasonable to suggest that the downlight category has reached maturity, after being one of the first market segments to see viable products that clearly beat the competition from other source types. With a current mean efficacy of 68 lm/W and some products reaching as high as 120 lm/W, LED downlights are substantially more energy efficient than are halogen or CFL downlights. A large percentage of LED downlights also offer high color fidelity, and good lighting quality in general—something that CFL downlights usually do not deliver.

While LED downlights can be lauded for the diversity of options and superiority over legacy light sources, their performance lags behind that of many other LED luminaire categories. Troffer, linear, directional, wall-wash, area/roadway, parking garage, and industrial luminaires all have higher mean efficacy, and all but wallwash luminaires have higher maximum efficacy. Some of the discrepancy is due to different optical requirements; when additional optical materials are needed to shape the light distribution and/or reduce glare, efficiency is generally reduced. But as was discussed in the last CALiPER Snapshot report on MR16 lamps, the relatively low performance of conventional halogen and CFL downlights provides less incentive for continued efficacy gains in LED downlights, compared to luminaire types competing against linear fluorescent or high-intensity discharge incumbents. Further, efficacy gains for LED downlights have slowed in the past year or two; this mirrors a trend in troffers and other luminaire types, but is more notable for downlights because the efficacy is already low among LED products.

The importance of efficacy gains is not solely related to energy savings. Improved LED package efficiency can simplify thermal management and allow more flexibility in product design, ultimately reducing product cost. With the average LED downlight listed by LED Lighting Facts at just one-third of the DOE target for efficacy for LED luminaires, there is substantial room for continued performance gains, which should not be overlooked.

The Fine Print **About LED Lighting Facts Snapshot Reports**

Snapshot reports analyze the dataset—or subsets—from DOE's LED Lighting Facts product list. They are designed to help lighting retailers, distributors, designers, utilities, energy efficiency program sponsors, and other industry stakeholders understand the current state and trajectory of the solid-state lighting market. Product classifications are at the discretion of the manufacturer, and Snapshot reports generally reflect the raw data listed in the LED Lighting Facts database. Minimal action is taken to adjust for inconsistencies.

The LED Lighting Facts database is not a statistical sample of the overall market. LED Lighting Facts is a voluntary reporting program in which manufacturers submit data for products tested in accordance with IES LM-79-08. Within any category, the data may be skewed not only by what is submitted, but also by the reporting practices of different manufacturers (e.g., reporting each small variation of a product). Given the broad nature of some of the predetermined categories, not all individual products may be directly comparable (i.e., the form factor may be substantially different). Despite these limitations, the LED Lighting Facts database is the largest of its kind, and is generally considered indicative of market trends. The product list includes a wide variety of product types, from manufacturers large and small, lighting industry veterans and brand new companies alike.

LED Lighting Facts and the Snapshot reports focus on five core metrics: lumen output, input power, luminous efficacy, color rendering index, and correlated color temperature. Data for other performance metrics can be voluntarily submitted, and all data is available on the LED Lighting Facts website. Specifiers should thoroughly consider all aspects of performance when evaluating different products.

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Energy Efficiency &
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